U.S. Department of the Interior
U.S. Geological Survey

VOLCANOES! CREATORS AND DESTROYERS

LESSON 2

On May 18, 1980, Mount St. Helens erupted violently. At 8:32 a.m. Pacific Daylight Time, a magnitude 5.1 earthquake occurred about a mile beneath the volcano, triggering a catastrophic series of events that transformed Mount St. Helens' picturesque mountain landscape into a gray wasteland.

The Catastrophic Eruption

The earthquake shook the walls of the volcano's summit crater and triggered many small rock avalanches. Within seconds, a huge slab of the volcano's north flank began to slide, and small dark clouds billowed out of the base of the slide. Plumes of steam and ash also rose from the volcano's crater. As the avalanche of rock and ice raced down the mountain's north flank at more than 250 kilometers per hour (155 miles per hour), a massive explosion blasted out of the north side of the volcano. This ***lateral blast*** became a fearsome torrent of ash and rock that outraced the avalanche. Probably no more than 20 to 30 seconds had elapsed since the triggering earthquake!

The Eruption Was No Surprise

The eruption of Mount St. Helens was not a surprise. For nearly 2 months, scientists had been monitoring changes at Mount St. Helens. For a volcano to erupt, magma must move to the Earth's surface. Increased earthquake activity, eruptions of steam and ash, and changes in the shape of the surface of the volcano all signal that magma is on the move toward the surface.

Inside the volcano, the solid rock that surrounds the molten rock often cracks from the increased pressure and causes earthquakes. Between March 20 and May 18, more than 10,000 earthquakes were recorded beneath Mount St. Helens. The largest of these were felt by people living near the volcano. In addition to recording the discrete jolts characteristic of earthquakes, ***seismographs*** also detected continuous rhythmic vibrations called ***harmonic tremors***. These numerous small earthquakes were further evidence that magma was moving within the volcano.

As magma made room for itself inside the volcano's cone, the surface of the volcano swelled, or inflated. By early April, Mount St. Helens' north flank began to visibly bulge and crack. The bulge grew 2 to 3 meters (7 to 9 feet) a day and it moved outwards about 150 meters (450 feet) in 2 months.

When the 5.1 magnitude earthquake shook Mount St. Helens on May 18, 1980, the bulge collapsed. The resulting avalanche was the largest ***volcanic avalanche*** recorded in historical times. In turn, the sudden removal of masses of rock and ice by the avalanches triggered an explosive eruption of steam trapped in cracks and voids in the volcano and of gases dissolved in the magma. Unleashed by the abrupt release of pressure, magma, rock, ash, ***aerosols***, and gases exploded from within the volcano's north flank.

The Mountain is Transformed

In a few minutes, Mount St. Helens symmetrical cone was transformed. It was 400 meters (1,312 feet) shorter and a gaping crater was gouged into its north side. An avalanche of rock, ash, ice, water, and fallen trees flowed as far as 9 kilometers (15 miles) down the valley of the North Fork Toutle River. Debris dumped into Spirit Lake raised the lakebed by more than 940 meters (295 feet). The lake's cool, crystal-clear waters became a black stew of rocks, mud, and floating trees. Gone were 70 percent of the ***glaciers*** that had crowned the volcano, melted by the heat of the eruption or carried away by the fast-moving avalanche. Towering forests with trees up to 45 meters (150 feet) were flattened and strewn like match sticks in the wake of the lateral blast and debris-laden avalanche.

Eruptions Continue

Between May 18, 1980, and October 1995, Mount St. Helens has had at least 21 eruptions of magma and dozens of smaller gas explosions. All of the volcanic activity has taken place in the bottom of the crater created by the May 18, 1980, eruption. There Mount St. Helens is rebuilding itself. During each eruption, new lava squeezes up and pushes aside old material from the surface of the ***dome***. The volcanic activity that began in 1980 is not yet over.

Activity 1 The Mountain Blows its Top

45 minutes
By observing **two demonstrations**, students will understand (1) why a bulge developed on the north flank of Mount St. Helens and (2) why the avalanche triggered an explosive eruption.

Key teaching points

1. The bulge that developed on the north flank of Mount St. Helens was evidence of changes occurring inside the volcano. Magma was moving closer to the surface and inflating, or deforming, the side of the volcano.

2. Scientists had been closely monitoring the growth of the bulge for nearly a month to help them try to forecast an eruption.

3. The 5.1 magnitude earthquake on May 18, 1980, shook the volcano, including the bulge area. In turn, the shaking of the bulge area caused a sudden collapse of the volcano's north flank and triggered a large avalanche.

4. The removal of this large mass of rock by the avalanche caused a sudden release of pressure inside the volcano and a violent eruption occurred.

Materials

1. 1,500 ml beaker (Pyrex™)
2. Damp sand
3. Several small balloons
4. Rubber bands
5. Bunsen burner or hot plate
6. Straight pin
7. A bottle of soda water
8. Basin or bowl to catch the "explosion"
9.. Master Sheet 2.1

Procedures

Preparation

Before class begins, put about ½ inch of sand in the bottom of the beaker and level the surface of the sand. Partially inflate a balloon, secure it with a rubber band, and place the balloon on top of the sand in the beaker. Cover the balloon with sand to a depth of about 1½ inches. Level the surface of the sand.

Introduction

In class begin the lesson by reviewing **the series of events** that occurred on May 18, 1980. Use Master Sheet 2.1 to discuss the following events: the **bulge** that had been growing on the north side of the volcano for a month, the 5.1 magnitude **earthquake** that triggered an **avalanche**, and the avalanche that unleashed an explosive eruption, a **lateral blast**.

Demonstration 1: Why the bulge grew

1. Partially inflate a balloon. Ask students what would happen to the balloon if you were to heat the air in the balloon? (The balloon would expand because the air expanded.) Explain that inflation caused a bulge to develop on the north flank (side) of Mount St. Helens.

2. Tell the students that the inflated balloon represents the magma rising within Mount St. Helens and that the sand represents the surface of Mount St. Helens. (*fig. 1*)

3. Show the beaker to the students and tell them you have a partially inflated balloon in the beaker. Place the beaker on the Bunsen burner or the hot plate. Heat the beaker until the balloon begins to expand. (The surface of the sand should begin to "bulge".) (*fig.* 2)

4. Observe the changes in the shape of the surface of the sand. What happens to the "land" as the "magma chamber" expands?

Demonstration 2: Why the avalanche triggered the explosive eruption

1. Ask students what would happen if you were to stick a pin into the balloon. (It would pop or explode.) Why does it explode? Burst the balloon. (The balloon bursts because the pressure inside the balloon is suddenly released and the gases can escape rapidly.)

2. Ask students what happens when they open a bottle of soda. (It goes "fizz" because the gas, CO_2, in the soda escapes.) Demonstrate this by shaking a bottle of soda water and releasing the cap. (The soda water "erupts" out of the bottle.)

3. Return to the the poster (*poster fig.1*). Compare the soda bottle to a magma chamber. As long as the top is on the bottle, there is no eruption. Compare the rock and ice that was unloaded by the avalanche to the soda cap. When the "cap" was suddenly removed, the pressure inside the volcano was suddenly released, and the volcano erupted.

fig. 1

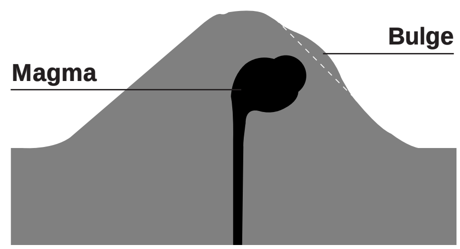
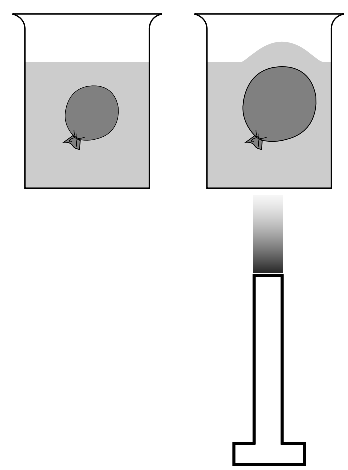


fig. 2



Activity 2 Mapping Mount St. Helens

30-minute demonstration
45-minute work session
Students use ***topographic map*** skills to interpret the impact of the May 18, 1980, eruption of Mount St. Helens on the volcano's topography.

This activity is divided into an **introduction, a demonstration,** and **a student work session.**

In the **demonstration** you (1) introduce students to topographic maps and contour lines and (2) construct a simple three-dimensional model of Mount St. Helens before the May 18, 1980, eruption.

In the **work session**, students draw ***profile views*** of Mount St. Helens before and after the May 18, 1980, eruption. Students use these profiles to interpret the changes in the mountain's topography that were caused by the eruption.

Key teaching points

1. Because volcanic eruptions both create and destroy landforms, they cause changes on the surface of the Earth's lithosphere. The May 18, 1980, eruption of Mount St. Helens destroyed a significant portion of the mountain that had been created by previous eruptions.

2. Within a few minutes of the start of the eruption, the mountain lost 400 meters (1,312 feet) of its height and a gaping crater 625 meters (2,050 feet) deep, 1.7 miles (2.7 kilometers) long, and 1.3 miles (2 kilometers) wide opened on its once nearly symmetrical cone.

3. The changes to Mount St. Helens' landscape have been recorded on topographic maps. Topographic maps represent the three-dimensional features of a landscape on a two-dimensional surface.

Materials

1. Master Sheet 2.2
2. Play-doh®
3. Scissors
4. Activity Sheet 2.1 (2 sheets)

Procedures

Introduction

1. Begin this activity by showing the class the photograph on the poster of Mount St. Helens taken before the 1980 eruptions (*poster fig. 10*).

2. Remind students that Mount St. Helens began erupting about 40,000 years ago, but most of its height formed over the past 2,500 years from repeated eruptions. At the time of the May 18, 1980 eruption it was 2,780 meters (9,677 feet) high. Some eruptions can destroy part of the mountain that earlier eruptions have built.

3. Look at the photograph (*poster fig. 11*) taken after the May 18, 1980 eruption. Ask students what they think the impact of the May 18, 1980 eruption was on the shape and size of Mount St. Helens.

4. Tell students that they will use topographic maps of Mount St. Helens before and after the May 18, 1980 eruption to verify or refute their observations.

5. Use a transparency of Master Sheet 2.2 to explain that a topographic map shows topography — the highs and lows of a given area.

- Topographic maps use special lines called ***contour lines*** to show the shape and elevation of the land.
- On this map, each contour line represents 100 meters (330 feet) change in elevation.
- With your finger trace the "2,000" meters contour line.
- Tell students that if they were walking on this imaginary line, they would never go up or down. To walk up or walk down, they would have to change lines—much like walking up or down steps.

Demonstration:
A profile model of Mount St. Helens before the 1980 eruption.

1. Make a transparency and 4 photocopies of Master Sheet 2.2 (topographic map of Mount St. Helens before the 1980 eruptions).

2. Use the transparency to show students the topographic map of Mount St. Helens before the 1980 eruptions.

3. Tell your students that you will use this topographic map to " build" Mount St. Helens before the 1980 eruptions. (*fig. 3)*

4. Cut along the 1,400 meters contour line to make a pattern. Roll out Play-doh® about ½ inch thick and place the cutout on top of the Play-doh®. With a sharp point, trace along the contour line to form your first layer.

5. Cut along the 1,600 meters contour line to make a second pattern. Roll out Play-Doh® about ½ inch thick, place the pattern on top of it, and trace along the contour line to make your second layer. Stack layer 2 on top of layer 1, like building a tiered wedding cake.

Using Topographic Maps

Topographic maps use contour lines, which are imaginary lines that connect all points at the same elevation. By reading these lines, you generally can tell: (1) the elevation of the land, (2) the steepness of a slope, and (3) the shape of the land.

— **Contour lines are always parallel. They never cross.**

— **The closer together the contour lines, the steeper the slope.**

— **Closed depressions, such as a volcanic crater, are marked with short lines pointing downslope.**

— **Every fifth contour line is made heavier and the elevation is always marked. (This makes contours easier to read and count.)**

Activity 2 Continued

fig. 3

6. Repeat this process for the 1,800, 2,000, 2,200, 2,400, 2,600, and 2,800 meters contour lines.

7. Give students an opportunity to look at the model. Have them pay special attention to the side view, or profile, as a preparation for their work session.

Work session: Drawing profile maps

1. Hand out Activity Sheets 2.1. Map A is a topographic map of Mount St. Helens before the 1980 eruptions. Map B is a topographic map of Mount St. Helens after the eruptions.

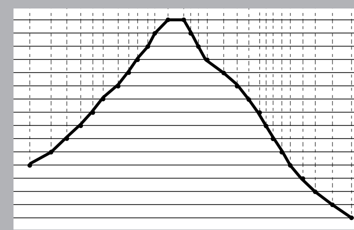
2. Following the directions on their Activity Sheets, students use topographic maps to draw a profile (side view) of Mount St. Helens before and after the 1980 eruptions.

3. Students compare the completed profiles to see how the eruption changed the size and shape of Mount St. Helens.

4. As a class, calculate how many meters in elevation Mount St. Helens lost as a result of the May 18, 1980, eruption. (400 meters/1,312 feet)

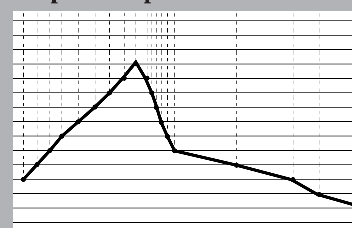
Activity Sheet 2 Answers

Map A completed



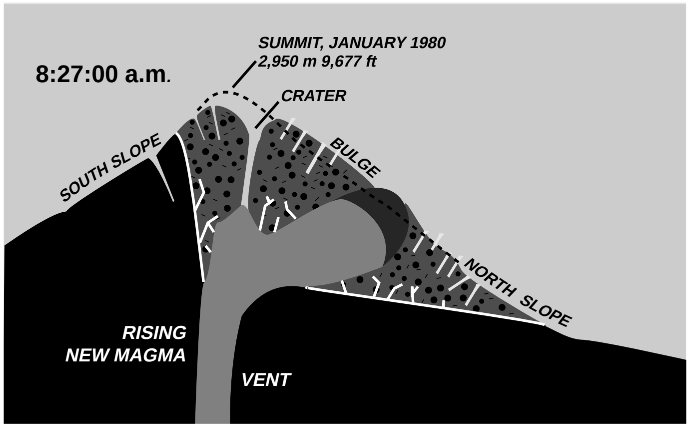
1. Cone shape; mountain-like
2. 2,800

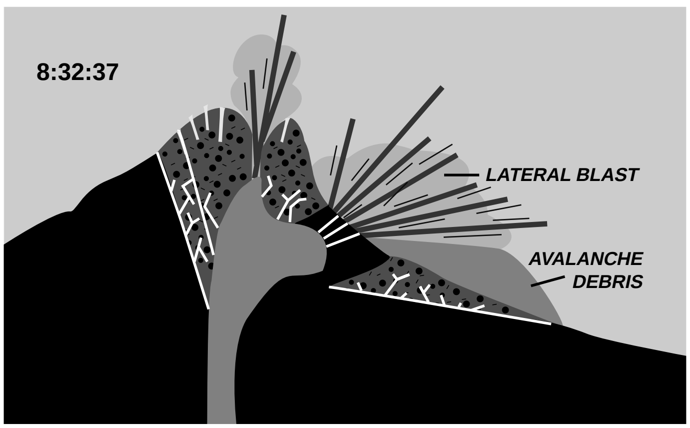
Map B completed

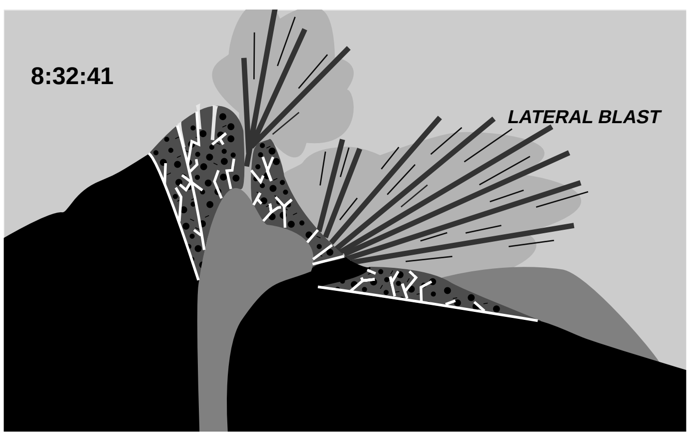


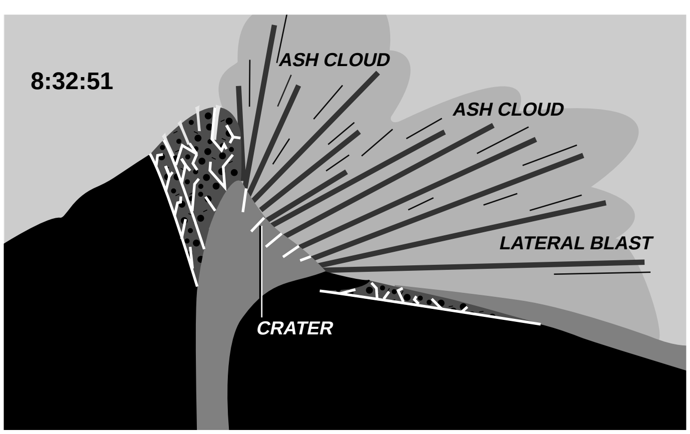
5. Yes. Part is missing. It is no longer a cone.
6. About 2,400 meters
7. Lower
8. Bigger

Master Sheet 2.1

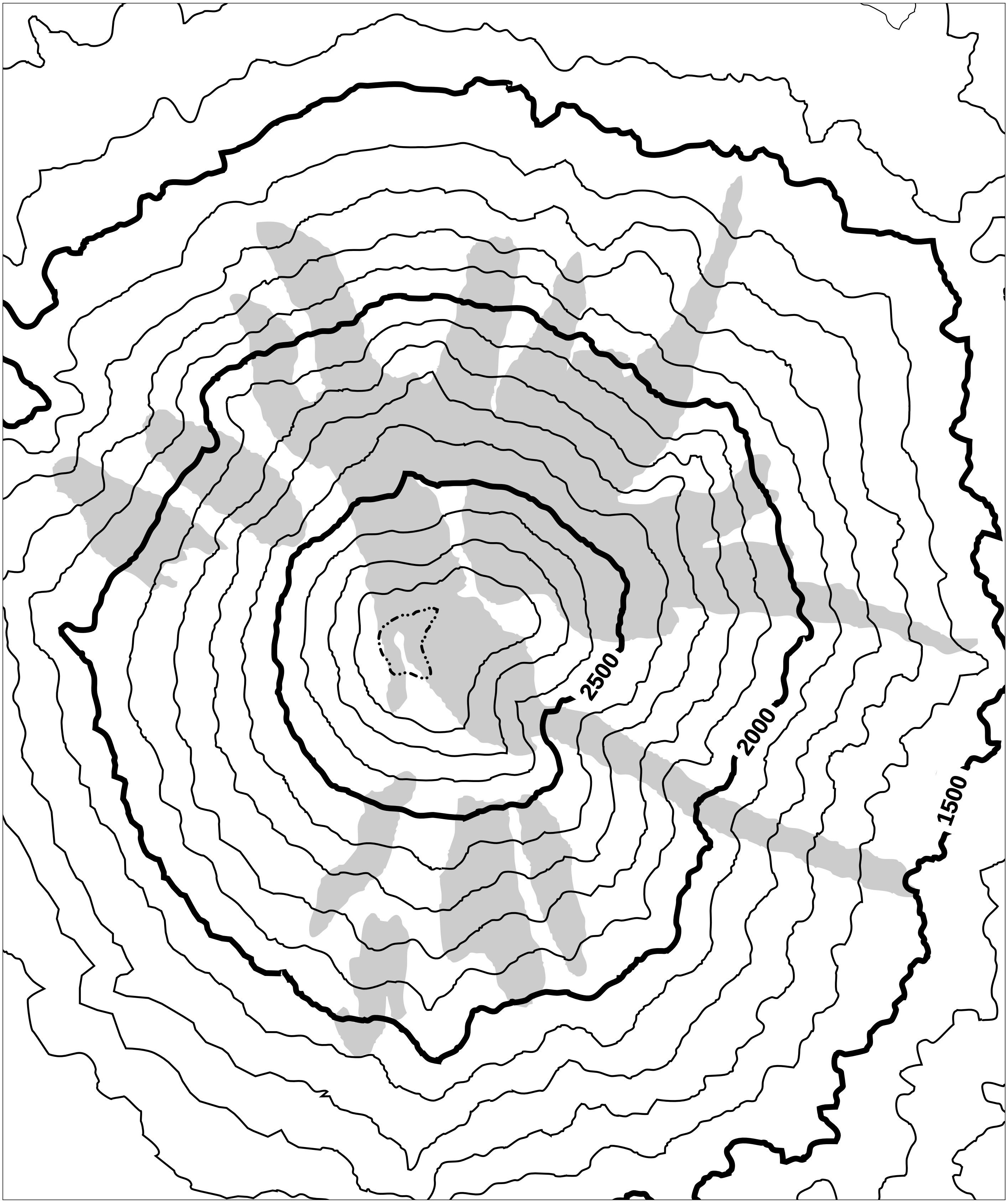








Master Sheet 2.2



Legend

0 1 km

Contour interval
100 meters

Glaciers

Crater

N

VOLCANOES!

Activity Sheet 2.1Map A
The Mountain Blows its Top

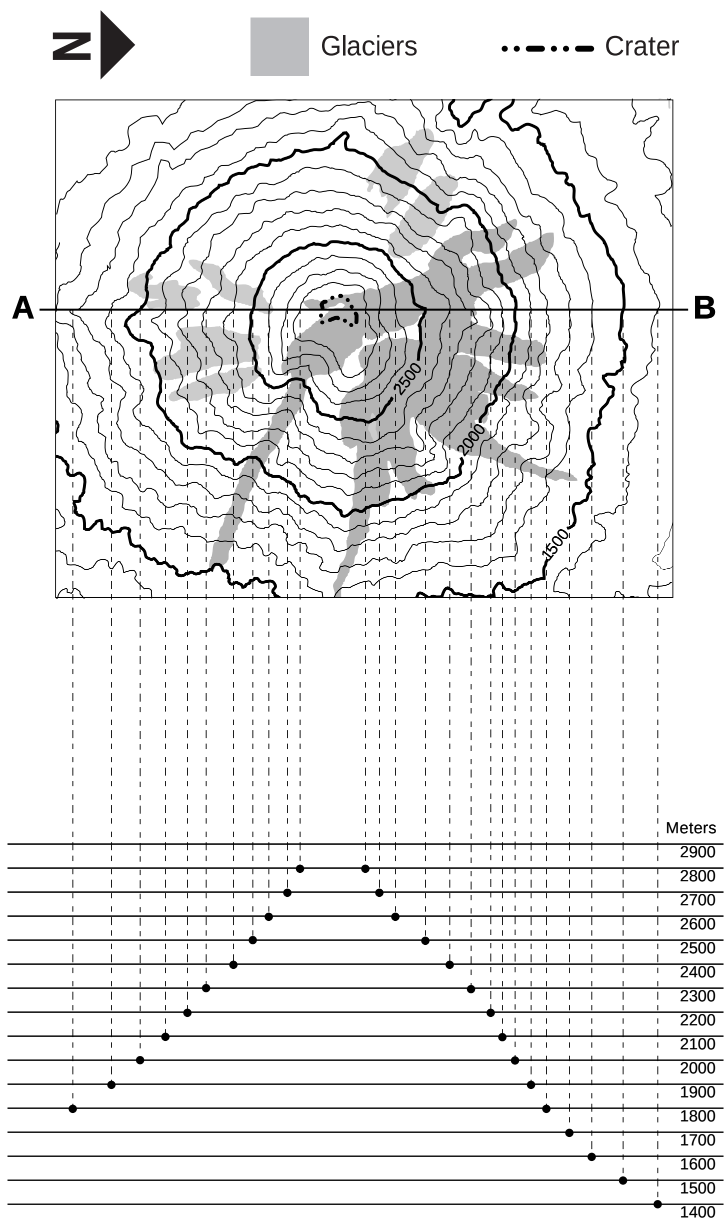
These are ***topographic maps*** *of Mount St. Helens.*
Map A *is Mount St. Helens before the 1980 eruptions and* ***Map B*** *is Mount St. Helens after the May 18, 1980, eruption. Compare these maps and you will see how the eruption changed the size and shape of Mount St. Helens.*

What do Topographic Maps Show?

Topographic maps show the shape and elevation of the land by using special lines called *contour lines.* A contour line is an imaginary line that connects points at the same elevation, or height. Elevation is how high, or low, the land is above sea level. Sea level is “0” meters. On these two maps, each contour line equals a 100 meters (330 feet) change in elevation. To make the lines easier to read, every 500 meters (1,550 feet) is shown in a heavy black line.

Map A: Before the Eruption

The **top of this drawing is a topographic map** of Mount St. Helens before the 1980 eruption. It shows the volcano’s shape and elevation as if you were looking at the volcano from the air. The **bottom of this drawing is a profile view.** It shows the volcano’s shape and elevation from the side.



What to do

1. On the bottom illustration, connect the dots.
   What shape have you drawn?

____

2. Find the highest point on the bottom illustration, put an “X” there. To find the approximate elevation, trace your finger across to the numbers on the left side.
   That number is about ___________ meters.

VOLCANOES!

Activity Sheet 2.1Map B
The Mountain Blows its Top

Map B: After the Eruption

The top of this drawing is a topographic map of Mount St. Helens after the May 18, 1980, eruption. You will draw a profile view at the bottom to see how the shape and elevation of the volcano changed after the eruption.

What to do

1. Find the contour lines on the topographic map. Trace your finger around the 2,000 meters contour line.

2. Draw a line between the letter “A” and the letter “B.” This line cuts across the top of the volcano.

3. Starting from “A” trace across the line until you cross a contour line. At that point, draw a line down to the chart below until you find the same number. Put a •. Repeat until you get all the way across line A——B. We have done the first few for you.

4. Connect all the dots.

5. Has the shape of the volcano changed? How?

____

____

____

6. Find the highest point. How many meters high is the volcano?

____

7. Is the volcano higher or lower than before the eruption?

____

8. Find the crater. Is it bigger or smaller than before the eruption?

____